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Wagner

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[54] **PNEUMATIC IMPACT GUN**

[75] Inventor: **David Lee Wagner**, Kent, Wash.

[73] Assignee: **The Boeing Company**, Seattle, Wash.

[*] Notice: The portion of the term of this patent subsequent to Aug. 2, 1994, has been disclaimed.

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[22] Filed: **Jul. 8, 1977**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 699,772, is a continuation-in-part of Ser. No. 591,972, Jun. 30, 1975, abandoned.

[51] **Int. Cl.**[2] **B21J 15/18**

[52] **U.S. Cl.** **173/137**

[58] **Field of Search** 91/5; 173/15, 135, 136, 173/137

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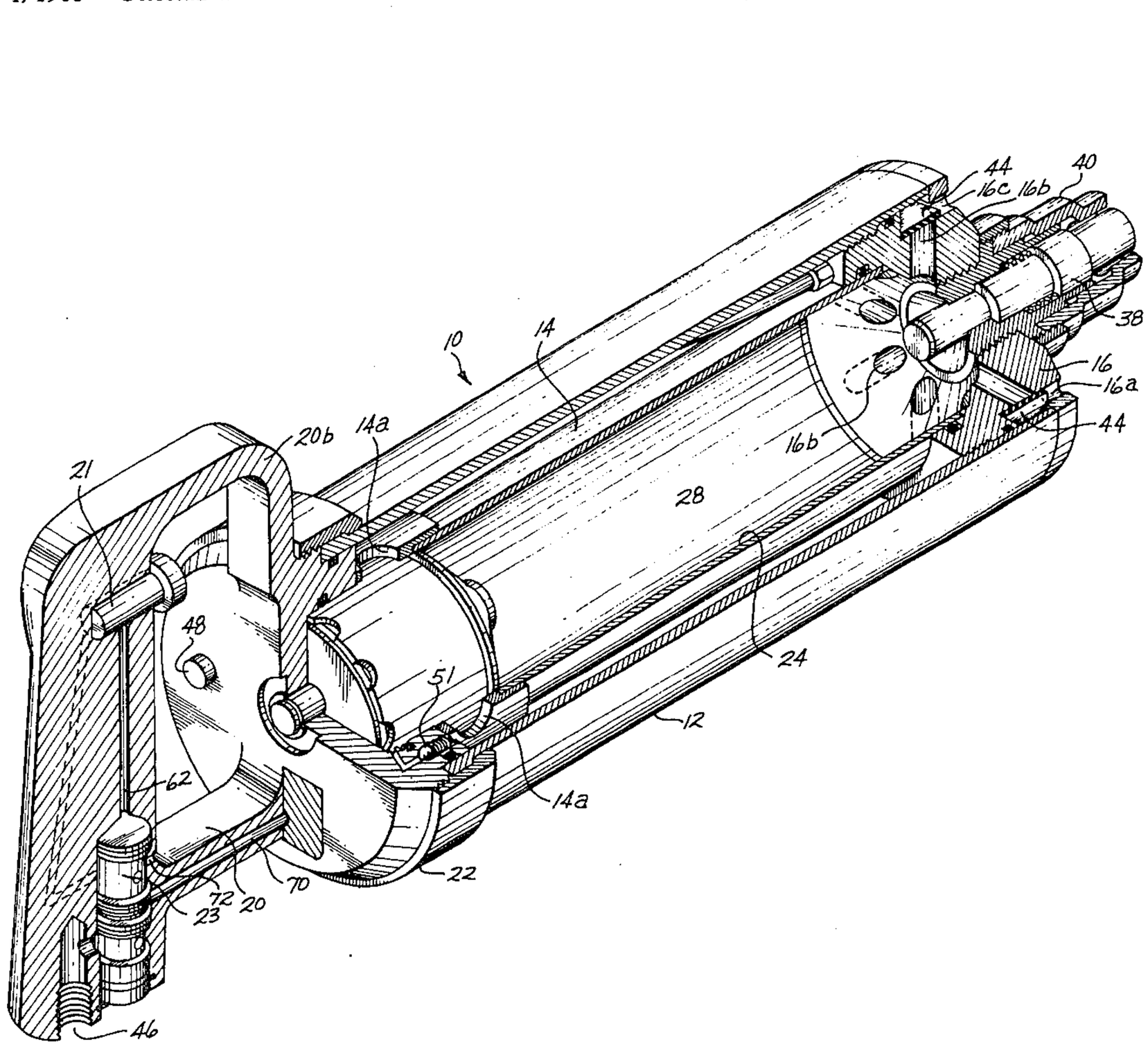
Primary Examiner—Lawrence J. Staab

Attorney, Agent, or Firm—Lynn H. Hess; Bernard A. Donahue

[57] **ABSTRACT**

A pneumatic impact gun having an accumulator and interlock system for rapidly dumping a predetermined amount of compressed air into a cylinder to thereby propel an associated piston toward an anvil for contact with a rivet to be upset. The interlock system prevents accidental firing of the gun until a normally open interlock valve is manually depressed. Thereupon, a trigger valve may be manually opened to permit compressed air from a source to open a main valve and charge the accumulator to a predetermined pressure. The air in the accumulator may then be rapidly dumped therefrom into contact with the piston. Additionally, a metering valve serves as an energy selector to permit selective charging of the accumulator for varying the resulting impact of the piston onto the anvil.

3 Claims, 4 Drawing Figures



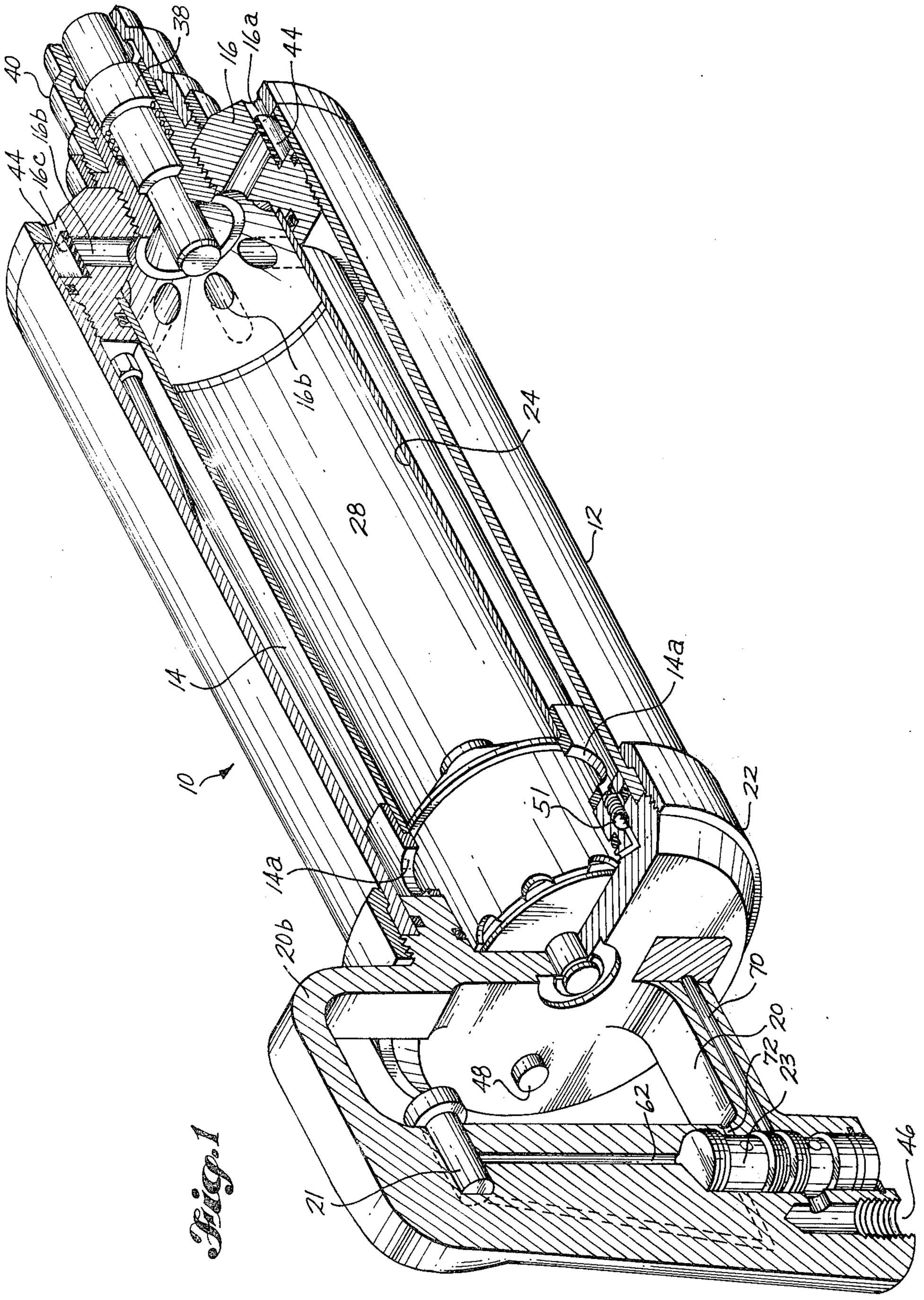

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Fig. 1

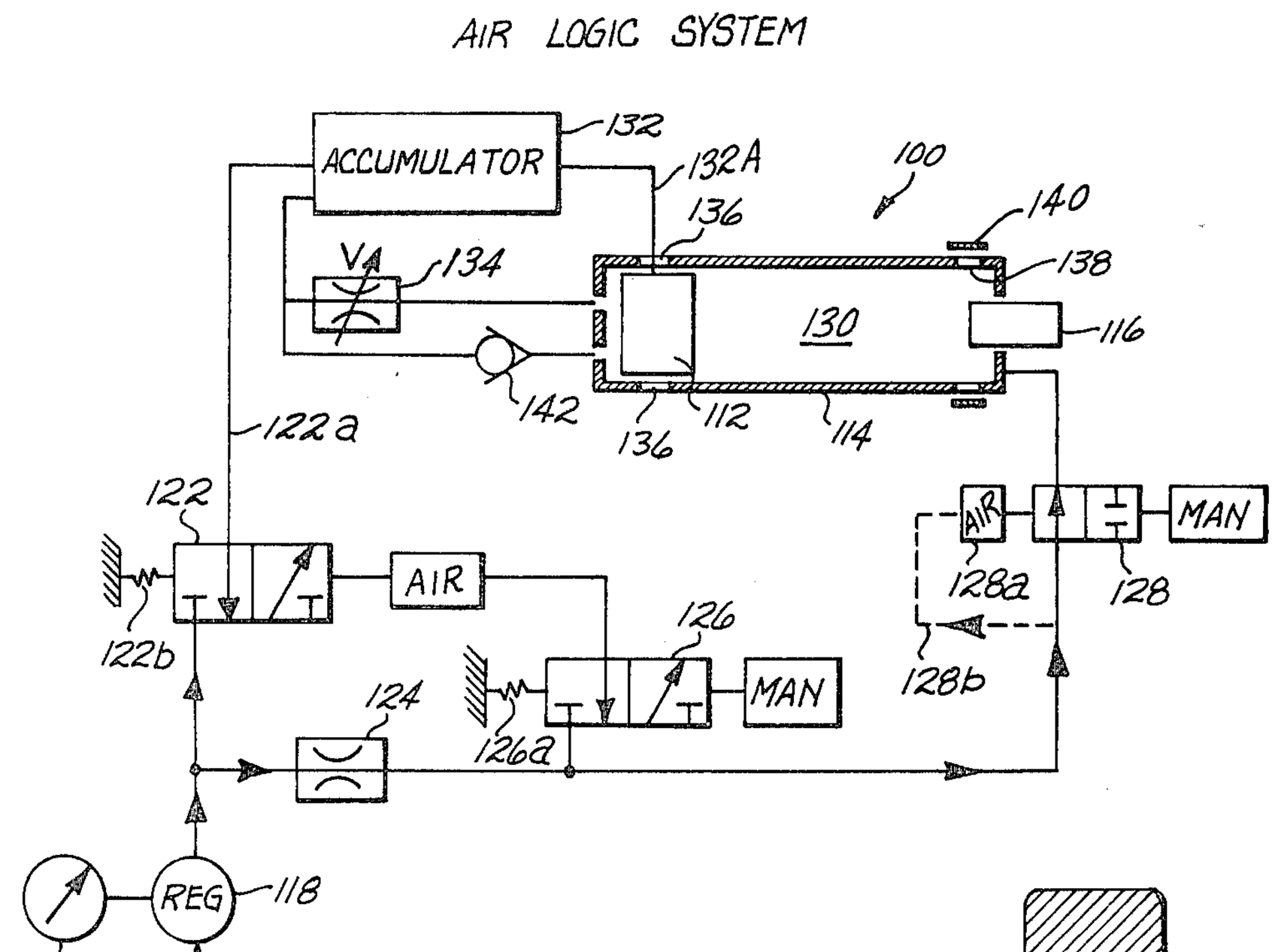


Fig. 2

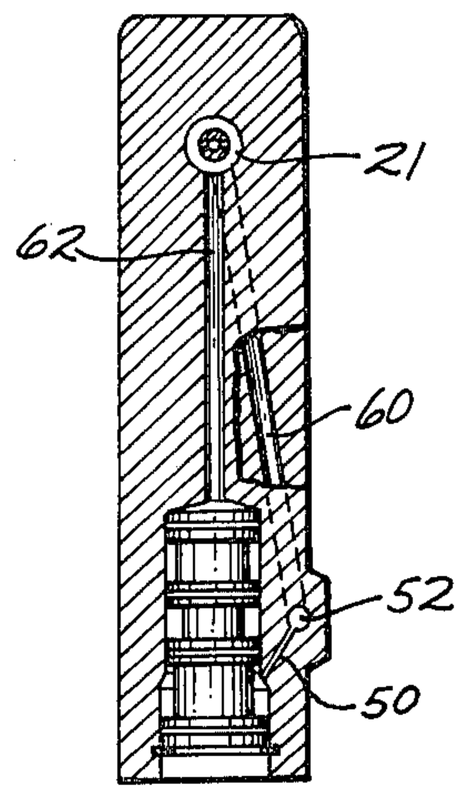
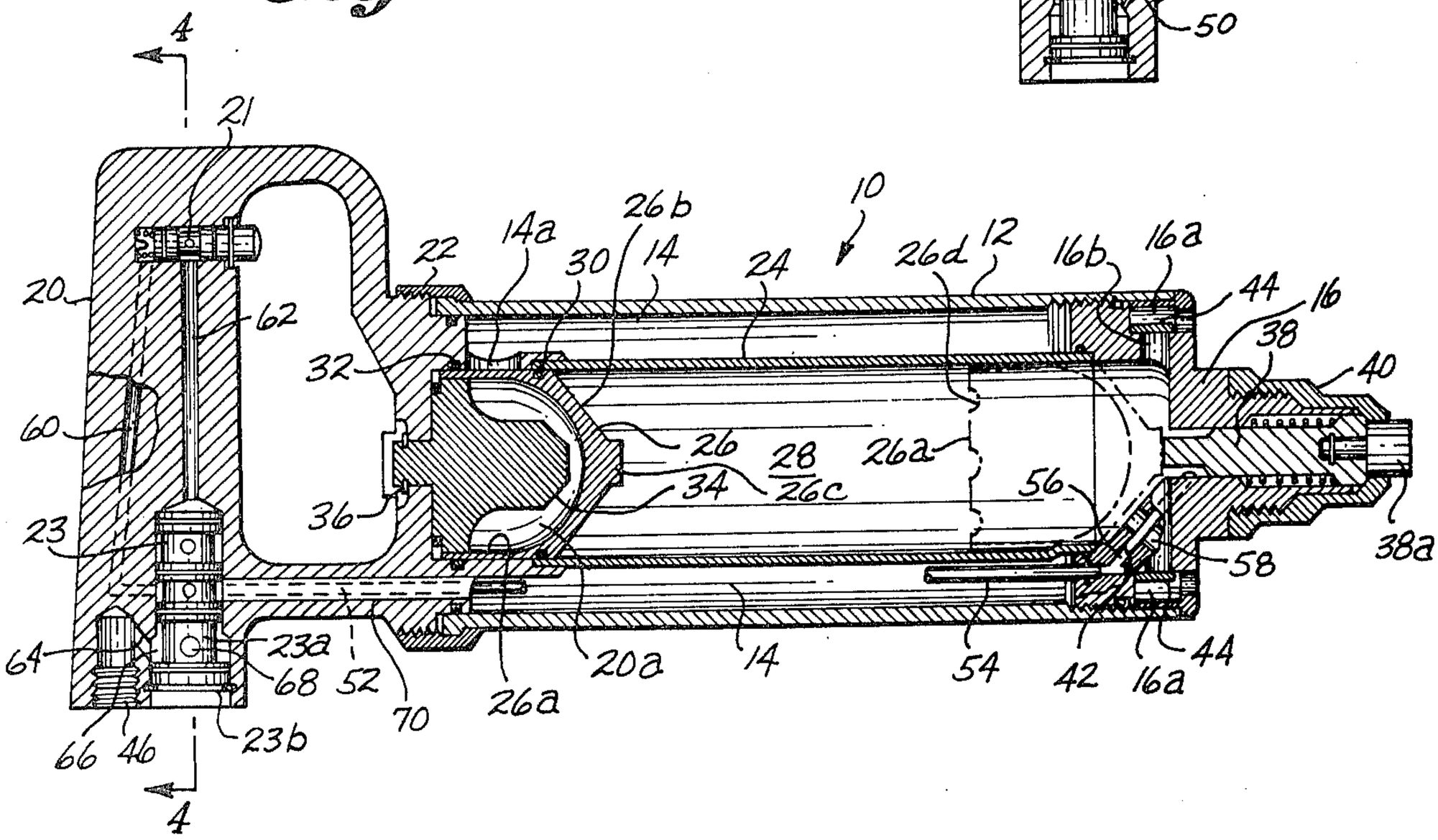


Fig. 4

Fig. 3



PNEUMATIC IMPACT GUN

CROSS REFERENCE TO RELATED APPLICATIONS

This application is a continuation-in-part of application Ser. No. 699,772, filed June 25,1976, now U.S. Pat. No. 4,039,034, which is a continuation-in-part of application Ser. No. 591,972, filed June 30, 1975, now abandoned.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to riveting devices and more particularly to a pneumatic impact gun designed to upset conventional rivets in a single impact.

2. Description of the Prior Art

The majority of pneumatic impact guns presently marketed require that a plurality of impacts be effectuated in order to upset a rivet. Such a plurality of impacts is undersirable for several reasons. First, attendant noise levels are often objectionable. For instance, the Federal Government's Office of Safety and Health Administration has promulgated standards in order to reduce noise levels in factories and other industrial areas. Furthermore, a lightweight pneumatic gun which upsets rivets in a single impact would greatly reduce the time required in the aircraft industry to rivet component sheets of a fuselage, wing skin, etc.

In order to provide a lightweight pneumatic single impact riveting gun, the present invention contemplates the use of a novel accumulator arrangement which will rapidly discharge or dump stored compressed air into a cylinder for actuation of a piston which will strike an anvil. The anvil impacts a rivet shank with sufficient energy to upset or form a button on the rivet in a single impact.

The Boeing Company has utilized pneumatic impact guns for many years, but there has not been a sufficiently lightweight single impact riveting gun until the present invention. In U.S. Pat. No. 3,559,269 by H. A. Schmitt et al., there is disclosed a high impact portable riveting apparatus. This patent provides for a sufficiently adequate single impact riveting apparatus, but requires the use of complex and expensive electric circuitry in order to adequately function. It is readily apparent that the present pneumatic impact system utilizing a lightweight gun sifficiently powerful to upset standard rivets in a single impact is greatly advantageous to the apparatus disclosed in the aforementioned patent.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide a pneumatic impact gun which is actuated by a normally discharged accumulator and which further utilizes an interlock system to prevent accidental firing. The pneumatic impact gun of the present invention is designed as a lightweight tool in which the actuating piston travels at a high velocity in order to strike an associated anvil with sufficient force so that a rivet may be upset in a single impact.

Another object of the present invention is to provide a lightweight pneumatic impact gun which will obviate the requirement of multiple impacts and thereby improve the quality of installed rivets and improve the rivet button appearance. Furthermore, by eliminating a

plurality of impacts objectionable noise will be substantially abated.

Yet another object of the present invention is to provide a lightweight pneumatic impact gun which incorporates a unique interlock system which provides for operator and work safety by preventing accidental discharge or firing of the impact gun when it is dropped or mis-handled. The interlock is used in conjunction with an accumulator which is normally discharged. The accumulator may only become charged with sufficient air pressure after the interlock and a trigger have been actuated.

A further object of the present invention is to provide a lightweight pneumatic impact gun which weighs approximately 5-½ pounds and is capable of upsetting 3/16-inch diameter rivets. Accompanying the lightweight construction of the impact gun of the present invention is a vertically offset handle which enables an operator to more fully adjust for recoil after the gun has been fired. The vertically offset handle centers the recoil mass (gun and operator's hand and arm) along the line of fire causing recoil travel to be parallel with the line of fire. As a result, the recoil of the gun is relatively straight and not off at an angle which would cause a non-uniform rivet button appearance.

Still another object of the present invention is to provide a lightweight pneumatic impact gun which may be altered in order to upset rivets of a larger or smaller diameter. For example, the accumulator volume may be changed in order to provide for different air volumes imparted to the actuating piston.

Yet another object of the present invention is to provide a lightweight pneumatic impact gun in which the cycle time for upsetting a rivet is extremely short, (approximating one second). Furthermore, the pneumatic impact gun of the present invention is constructed with parts which may be disassembled in approximately one minute or less, thereby making all components easily accessible for maintenance.

A still further object of the present invention is to provide a pneumatic impact gun lightweight in construction which has a minimal number of moving parts and which is relatively inexpensive to manufacture and maintain.

Additional objects of the present invention reside in the specific construction of the exemplary apparatus hereinafter particularly described in the specification and shown in the several drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Novel features of the improved lightweight pneumatic impact gun in accordance with the present invention will be more readily understood from a consideration of the following description, taken together with the accompanying drawings, in which a preferred adaptation is illustrated with the various parts thereof identified by suitable reference characters in each of the views, and in which:

FIG. **1** is a cutaway view of the pneumatic impact gun illustrating the relationship of the cylinder and movable piston;

FIG. **2** is an illustration of the air logic system of the present invention;

FIG. **3** is a cross-sectional view of the pneumatic impact gun of the present invention illustrating certain features not shown in FIG. **1**;

FIG. **4** is a cross-sectional view of the handle taken along line **4—4** in FIG. **3**.

DETAILED DESCRIPTION OF THE INVENTION

Reference is directed initially to FIG. **2** which illustrates an air logic system employed in the present invention. By considering this diagram, the operation of the present invention may be readily understood. Structural components are further illustrated in FIGS. **1**, **3** and **4** and will be dsecribed later in detail.

As shown in FIG. **2**, the pneumatic impact gun and attendant circuitry is generally designated at **100**. A piston **112** is slidably arranged in a cylinder **114**. An anvil **116** is disposed downstream of piston **112** and is utilized to strike a rivet to be upset. In the FIG. **2** air logic system embodiment, shop air is controlled by a pressure regulator **118** and gage **120**. Typically, shop air pressure may be set to enter the system at approximately 100 p.s.i. Regulator **118** and gage **120** would normally be external to the gun and are optional equipment provided the air supply pressure is stable. A normally closed, three-way, two-position air pilot valve **122** remains initially closed and thus shop air passes through a restricter **124** and bypasses a trigger valve **126** so as to be admitted through an interlock **128** into cylinder chamber **130** for urging piston **112** to a normally home position.

In order to activate or fire the pneumatic impact gun **100**, it is necessary for the two-way, two-position, normally open interlock valve **128** to be manually actuated to prevent shop air from flowing therethrough. If the normally closed, three-way, two-position trigger valve **126** is now actuated, shop air will pass through restricter **124** and through trigger valve **126** to actuate main valve **122**. With main valve **122** permitting shop air to travel from the regulator **118** into accumulator **132** and energy selector **134**, the pneumatic impact gun is set for operation. Energy selector **134** provides a time delay to permit accumulator **132** to charge. Energy selector **134** permits only a small amount of air to displace piston **112** beyond ports **136**. As soon as piston **112** is displaced beyond ports **136**, accumulator **132** has been sufficiently charged with pressurized air to permit same to be dumped rapidly from accumulator **132** into the cylinder as represented by line **132***a* to force piston **112** to the right, thereby striking anvil **116**. As piston **112** travels at a high velocity through cylinder **114**, exhaust air is forced through ports **138** past elastic band **140**. Thus, the air is allowed to exhaust. As piston **112** impacts anvil **116**, interlock valve **128** is deactivated through an air return **128***b*, thereby permitting shop air to once again enter into chamber **130** to displace piston **112** to a home or start position. The elastic band **140** provides a constant pressure to keep piston **112** in its "ready for fire" position. During the travel of piston **112** to the left, a certain amount of air is displaced through one-way valve **142** and is exhausted outwardly through line **122***a*. Elastic band **140** shuts off air flow past the exhaust ports **138** until a predetermined pressure is developed by the continuous air bleed through restricter **124**. The resulting pressure is determined by the tension in the elastic band **140**. Upon actuation or firing, the air flow is sufficient to move the elastic band **140** clear from the exhaust ports **138**. Spring returns are diagrammatically indicated at **122***b* and **126***a*. An air return is indicated at **128***a*.

With reference now to FIGS. **1** and **3**, specific construction details of the lightweight pneumatic single impact gun of the present invention will be fully described. The gun is represented generally at **10**, and consists of a housing **12** having an accumulator cavity **14**.

The pneumatic impact gun utilizes a housing **12** wherein an accumulator cavity **14** is arranged circumferentially therein. A cylinder head **16** is threadably secured at a forward end thereof and a handle assembly **20** is fastened at the other end by a nut **22**. A cylinder **24** is contained between cylinder head **16** and handle assembly **20**. Contained within cylinder **24** is a piston **26** which travels in cavity **28** of cylinder **24**.

Piston **26** is a thin-walled cylinder with a hemispherical dome cap at the downstream end, and a socket cavity **20***a* at the upstream end. The hemispherical dome cap has shoulder **26***b* arranged radially at its base, and boss **26***c* located at the crown. Boss **26***c* is a wear surface for impacting anvil **38**. Contained radially within shoulder **26***b* is a narrow groove (not shown) to retain O-ring seal **30**.

At the upstream end of piston **26** is an external chamfer (not shown) arranged radially around the open-end of the cylinder. Within said chamfer are a plurality of shallow scallops **26***d* (shown by phantom lines in FIG. **3**) to provide an air passage for the air coming from admitting means **48**. The chamfer provides a means to engage seal **32** which is located in the wall of cylinder **24**.

Socket cavity **20***a*, within handle assembly **20**, contains seal **32** arranged in a radial manner to seal the outside surface of piston **26** during the time the piston is in the upstream position. As piston **26** moves downstream, and when scallops **26***d* clear seal **32**, the supply of air is unloaded into the void behind piston **26**, causing piston **26** to rapidly move downstream and impact anvil **38**.

Plug **34** located within handle socket cavity **20***a* displaces a volume of air within the upstream side of piston **26**. Since the walls of piston **26** are thin, plug **34** retains seal **32** within socket cavity **20***a* of handle assembly **20** when piston **26** is in the downstream position.

In the preferred embodiment, piston **26** is constructed from steel. A Teflon bearing surface is provided on the side of piston **26** which contacts the walls of cylinder **24**.

Cylinder head **16** further comprises an anvil **38** within anvil housing **40**. A shuttle **42** and elastic band **44** are also located in cylinder head **16**. Handle assembly **20** further contains a trigger valve **21**, a main valve **23** and an air intake **46**. A check valve **51** is utilized in conjunction with an adjustable metering valve **48** and a restricter passage **50** which leads to passage **52** (shown in FIG. **4**) connected to tube **54**.

Passage **62** connects trigger valve **21** to main valve **23**. Main valve **23** is retained by a retainer **23***a* and retaining ring **23***b*. Passage **64** connects an air intake **46** to a main valve cavity **66**. Main valve cavity **66** feeds restricter passage **50** and retainer ports **68** located in retainer **23***a*. A passage **70** connects main valve cavity **66** to accumulator **14** and check valve **51** connects cavity **20***a* and cavity **14** allowing flow from cavity **20***a* to cavity **14** but checking reverse flow. Adjustable metering valve **48** connects cavities **20***a* and **14** for metering high pressure flow from cavity **14** to cavity **20***a*. High pressure air is exhausted from main valve cavity **66** to atmosphere by means of exhaust passage **72**. Ports **14***a* connect cavities **14** and **20***a* for high volume high pressure flow. Cylinder head **16** utilizes cavities **16***a* which further incorporates elastic band **44**. Ports **16***b* connect

cavities **28** and **16***a*. Ports **16***c* connect cavity **16***a* to the atmosphere.

OPERATION OF THE PNEUMATIC IMPACT GUN

Initially conpressed air from a source of supply is connected to air intake **46**. Restricter passage **50** provides for a controlled volume of air flow to passage **52**. The controlled volume of air flow enters cavity **28** through tube **54**, passage **56**, and port **58** into cylinder head **16**. The controlled volume of air then flows to atmosphere through ports **16***b* and **16***c*. Elastic band **44** resists the flow and causes a low pressure to result in cavity **28**, thereby providing a means to return piston **26** to a home position and retain it there after firing of the gun.

Air flow in passage **56** retains shuttle **42** against anvil **38** which keeps port **58** open. With **58** in an open position, there exists low pressure in passages **56**, **54**, **52** and **60** because the air flow is restricted at passage **50**. With low pressure existing in passage **60**, manual actuation of trigger valve **21** will activate main valve **23**. Such a system provides an interlock to prevent accidental firing of the gun.

However, when anvil **38** is pressed against a rivet preparatory to firing the gun, shuttle **42** is caused to travel rearwardly in passage **56** to thereby block port **58**, and the continued flow through restricter **50** results in passages **52** and **60** having a high pressure buildup and therefore manual operation of trigger valve **21** will actuate main valve **23**. When main valve **23** is actuated, there is a high pressure, large volume of flow induced into cavity **14** from air intake **46**. As pressure builds in cavity **14**, there is a metered air flow therefrom to cavity **20***a* through metering valve **48** which builds a low pressure condition in cavity **20***a*, thereby causing piston **26** to move to the right as seen in FIGS. **1** and **3**. As piston **26** clears seal **32**, a large volume of air travels from cavity **14** to cavity **20***a* through ports **14***a* in a very short period of time, thereby accelerating piston **26** and storing kinetic energy in piston **26**. When piston **26** strikes anvil **38**, a button is formed upon a fastener or rivet. Exhaust air escapes to the atmosphere past elastic band **44** through ports **16***b* and **16***c* during the aforementioned working stroke. When anvil **38** is in home position, shuttle **42** is allowed to return, which thereby opens port **58**. The procedure bleeds air from passage **52** annd reduces the pressure, thereby deactivating main valve **23** and allowing high pressure exhaust to the atmosphere through main valve **23** and passage **70**.

Air pressure in cavities **20***a* and **14** is exhausted to the atmosphere through ports **14***a*, passage **70**, cavity **64**, and exhaust port **72**. The low pressure in cavity **28** will return the piston **26** home. Check valve **51** is utilized to bleed pressure from cavity **20***a* to cavity **14** after seal **32** is engaged. The gun is now ready for a repeat cycle. By utilizing the pneumatic impact gun of the present invention, cycle times of approximately one second have been realized.

The amount of energy imparted to piston **26** may be varied by adjusting air flow to metering valve **48** to cause a longer or shorter time delay to charge cavity **28** and displace piston **26** past seal **32** to fire. This longer or shorter time delay will allow accumulator cavity **14** to receive either a higher or lower pressure charge before firing. If a higher pressure charge is effectuated, the gun will deliver more energy at the corresponding higher accumulator pressures. an essential feature to be emphasized is the fact that accumulator cavity **14** is normally discharged.

Metering valve **48** may take the form of a needle valve or other conventional valving systems. However, it has been found that an eccentric valve arrangement may prove particularly beneficial. Such a metering valve cannot be jammed as can a conventional needle valve, and it is easily calibrated by design.

It is to be further noted that handle **20** incorporates a raised segment **20***b* which enables an operator's arm and wrist to be in line with the line of fire so that the gun does not tilt at an angle upon recoil.

While a certain exemplary embodiment of the present invention has been hereinabove desscribed and shown in the drawings, it is to be understood that such an embodiment is mereby illustrative of, and not restrictive on, the broad invention. Thus, the invention should not be limited to the specific construction or arrangement shown and described, since various other obvious modifications may occur to persons having ordinary skill in the art.

What is claimed is:

1. A pneumatic impact gun for upsetting one end of a rivet in a single impact comprising:

piston means slidably arranged in a cylinder for impacting an anvil disposed at the downstream end of said cylinder;

means for admitting a manually adjustable flow of air into said cylinder to displace said piston means a predetermined distance downstream within said cylinder over a variable time;

means for storing an accumulated charge of compressed air arranged to communicate with said piston means; and,

means for passing compressed air from said storage means so that when said piston means has been displaced a predetermined distance by the flow of compressed air from said admitting means, said storing means dumps an accumulated charge of compressed air into contact with the upstream side of said piston means to displace said piston means rapidly downstream in said cylinder to thereupon impact said anvil, wherein said piston means comprises a thin-walled circular cylinder with a hemispherical dome at the downstream end, said dome carrying shoulders therein and a boss thereon, said boss impacting said anvil when said piston moves downstream.

2. The piston of claim **1** wherein said shoulders contain a groove radially disposed therein, said groove retaining a seal.

3. The impact gun of claim **1** wherein said piston is made of steel.

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